

SOME METHODS OF STUDYING THE DISAPPEARANCE AND DECOMPOSITION OF LEAF LITTER*†

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Nylon netting has many advantages over materials previously used to contain leaf litter in the field. Studies have been made of the disappearance of birch, oak and lime litters in nylon hair-nets by determining the loss in weight after six months' exposure on mull, moder-type mor and deep acid peat sites. The greatest losses occurred with birch and lime litters on mull. The changes in nitrogen content of oak and ash litters exposed over a period of 59 weeks were also determined. A modified, rotary film evaporator proved a suitable apparatus for drying litter for Kjeldahl analysis.

INVESTIGATIONS on the processes of litter disappearance in woodlands are difficult to carry out because it is impossible to maintain the identity of experimental material without altering the effect of environmental conditions. Previous workers have confined litter samples in a variety of ways: FALCONER, WRIGHT and BEALL (1933), GUSTAFSON (1943) and NÖMMIK (1938) used wire containers; LUNT (1935) used wire mesh and wood; MIKOLA (1955) placed litter between layers of glass wool, and WITTICH (1939) placed litter directly on the ground and covered it with wire netting. In some of these investigations (Gustafson, Lunt and Nömmik) the small mesh size must have prevented entry of most of the litter-living meiofauna, a comment which probably also applies to Mikola's method. All these methods, with the exception of that of Wittich, would seem to prevent the experimental litter becoming incorporated into the natural litter layer, owing to the rigidity of the containers. In addition, in the investigations in which wire was used, it would be of interest to know whether the metal exerted any biological effect; stainless steel is the cheapest metal which could be used without running such a risk.

NYLON-NET TECHNIQUE

Bearing the previous work in mind, we explored the possibility of using materials which have become commercially available since the majority of the above studies were carried out. Nylon net was finally chosen because it is cheap, durable, biologically inert, strong and flexible. Other synthetic

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plastics have a number of these properties but only the plastic fibres have sufficient flexibility to allow the experimental litter to become incorporated with the natural litter layer. In the studies reported here we used untinted nylon hair-nets of 1 cm mesh. This mesh is large enough to allow the entry of all but the largest litter-inhabiting invertebrates, e.g. the larger Mollusca and Coleoptera; all lumbricids, isopods and diplopods could enter with ease. The choice of mesh size was a compromise; we wished to permit access to as many components of the litter fauna as possible while confining the experimental material. The constraint imposed upon the litter is, of course, an interference with the natural processes of disappearance; the effect of wind is reduced and the removal of leaves and leaf fragments by earthworms is hindered, both of which may be important factors in nature.

In a current experiment, the results of which are not reported here, we are using fine nylon net (mesh diameter 1 mm) in order to minimize the effect of the larger invertebrates on the disappearance of litter. A preliminary experiment using ash litter on mull has proved the feasibility of this modification. One drawback is that the microclimatic conditions within a fine-mesh net are greatly different from those within a coarse-mesh net, and consequently comparisons between the results obtained from coarse and fine nets are open to criticism.

DISAPPEARANCE OF LITTERS ON CONTRASTING SITES

The leaf litter of a number of tree species was collected at leaf fall in nets hanging clear of the ground. Among the tree species selected were birch (*Betula verrucosa* Ehrh.), oak (*Quercus robur* L.) and lime (*Tilia cordata* Mill.) all growing close together on a limestone ridge. The litter was air-dried in unheated rooms with open windows to give a final moisture content of 10–12 per cent (fresh weight). Twelve weighed sampling units of each litter, each containing a known number of leaves, were placed in nylon nets which were then distributed among three sites in Roudsea Wood Nature Reserve, North Lancashire, giving four units of each litter per site. Each net was placed on the natural litter layer and anchored in position with anodised-aluminium plant labels used as pegs.

The three sites chosen covered a wide range of woodland conditions (these are summarized in Table 67). The nets were placed in position on

Table 67. Characteristics of the experimental sites

Humus form	pH	Tree cover	Ground vegetation
Mull	A ₁ : 6.2–6.3	Mixed coppice of ash, hazel and birch	Sparse <i>Rubus</i> and <i>Mercurialis perennis</i> L.
Moder-type mor	A ₁ : 3.2–3.5	Oak–birch coppice	Thin sward of <i>Deschampsia flexuosa</i> Trin.
Deep acid peat	0–5 cm: 3.3–3.7	Small birch trees	Thick <i>Vaccinium myrtillus</i> L.

21st December, 1955, and within a few weeks they had become incorporated with the natural litter layer. The initial quantity of litter per net (ca. 1.8 g on dry-weight basis) represented about 400 g/m² (oven-dry weight), i.e.

about the same concentration as found in adjacent natural leaf aggregations. In later experiments we found it advisable to mark out our field sites permanently, using nylon tape in order to facilitate location of a net after incorporation had taken place. After six months (19th June, 1956) the nets were taken from the field and their contents examined. The leaves remaining were counted and, after removal of extraneous mineral matter and visible animals, each sampling unit was dried (105°C) and weighed (see *Table 68*).

Table 68. Amounts of leaf litters remaining in nylon nets after six months' exposure on contrasting sites

(number and mean oven-dry weight (g) \pm S.E. expressed as percentages; 4 sampling units per site)

Site	Tree species	Weight per net	Weight per leaf	Total No.
Mull	Oak	83.1 \pm 1.1	83.1 \pm 1.1	100
	Birch	18.3 \pm 6.4	73.8 \pm 8.1	24
	Lime	45.6 \pm 2.8	67.6 \pm 7.6	68
Moder	Oak	83.5 \pm 0.5	83.5 \pm 0.5	100
	Birch	74.4 \pm 0.6	75.2 \pm 1.3	99
	Lime	77.7 \pm 1.8	79.4 \pm 2.1	98
Peat	Oak	83.7 \pm 1.2	83.7 \pm 1.2	100
	Birch	72.9 \pm 2.0	72.9 \pm 2.6	99
	Lime	82.6 \pm 1.5	82.6 \pm 1.5	100

Results

The striking fall in numbers of lime and birch leaves on the mull is believed to have been due to earthworms dragging whole leaves from the nets. Two earthworms, *Allolobophora rosea* (Sav.) and *Lumbricus terrestris* L., are plentiful on this site. Presumably the oak leaves were too large, too tough or distasteful to be affected; the birch leaves, on the other hand, were easily removed owing to their small size. On the other sites, large litter-feeding invertebrates were not so abundant, and on these the only earthworm found after prolonged searching was *Bimastus eiseni* (Lev.), which probably cannot remove whole leaves from the nets.

Differences between sites and between the litters used is reflected in the weights of leaf material remaining per net; the moder and peat sites contrast with the mull, and the birch and lime litters contrast with oak.

When the amount remaining is expressed on a 'per leaf' basis the difference between sites disappears except in the case of lime on mull and peat, and even this difference is not significant at the 5 per cent level (analysis of variance). Thus the loss in dry weight, excluding that caused by the removal of whole leaves from the nets, is about the same on the three sites for any one litter, although the greater variation in the results for birch and lime on mull compared with the same species on the 'acid' sites indicates an important variable factor—probably animal activity—in operation on the mull site. Moreover, the differences between the three litters are remarkably small when the results are expressed on a 'per leaf' basis.

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NITROGEN CHANGES IN LITTERS ON CONTRASTING SITES

In order to differentiate mull and mor metabolically, samples of ash and oak litter in nylon hair-nets were placed (22nd November, 1956) on sites adjoining the mull and moder sites listed in *Table 67*. The samples were harvested periodically, dried and milled, and the powder then analysed for total nitrogen content by the Kjeldahl method.

Drying litter to a point at which milling becomes possible presented one difficulty, namely that rapid drying by heat can cause loss in total nitrogen and a derangement of the remaining nitrogenous fraction. We required a method which would bring about rapid drying under gentle conditions and yet keep microbial action to a minimum; freeze-drying, on the scale needed, was impracticable. However, we found that litter dried quickly at 38–40°C in a rotary film evaporator (CRAIG, GREGORY and HAUSMANN, 1950;

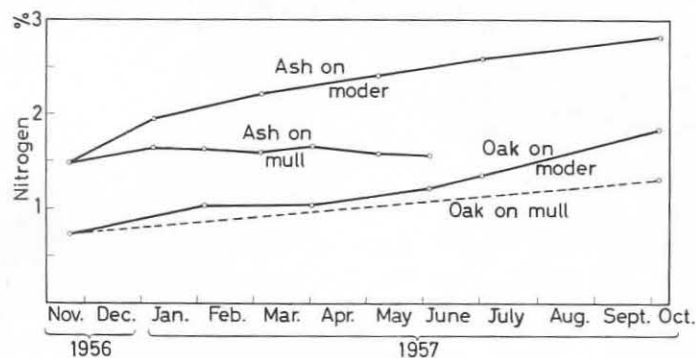


Figure 102. The nitrogen content (percentage oven-dry weight) of ash and oak litters placed on adjacent sites with contrasting humus forms.

BOCOCK and GILBERT, 1956) so long as the litter was not packed sufficiently tightly to prevent tumbling. It is believed that the anaerobic conditions caused by the reduced pressure inhibited microbial action. Although possible changes in the quality of the nitrogen fraction during drying by this method have not been investigated, changes in the total nitrogen content are negligible.

In an experiment, field-dried litter of hazel (*Corylus avellana* L.) was milled and two sets of subsamples taken: one for Kjeldahl analysis alone, and the second for Kjeldahl analysis after wetting and subsequent drying in a rotary film evaporator. The untreated samples had a mean nitrogen content on a dry-weight basis of 1.454 per cent (S.E. 0.008) and the experimental samples a mean of 1.437 per cent (S.E. 0.007) after five wetting–drying cycles. Using ‘Student’s’ *t* test the difference was found not to be significant at the 5 per cent level.

Results

The total nitrogen figures (*Table 69* and *Figure 102*) support the hypothesis that on the mull the loss of nitrogen by ash litter parallels the loss in dry weight, whereas on the moder, loss in nitrogen proceeds more slowly than this. On the mull, the major loss is presumably due to removal by the larger

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Table 69. Changes in nitrogen content of leaf litters on contrasting sites
(N as percentage of oven-dry weight; mean \pm S.E. of 4 subsamples
from bulked sample of each litter on each date)

Days from start of expt.	Ash on mull	Ash on moder	Oak on mull	Oak on moder
0	1.484 \pm 0.007	1.480 \pm 0.014	0.728 \pm 0.009	0.728 \pm 0.009
46	1.631 \pm 0.003	1.934 \pm 0.001		1.020 \pm 0.003
74	1.619 \pm 0.007			1.020 \pm 0.003
92	1.584 \pm 0.003	2.209 \pm 0.020		
130	1.648 \pm 0.006			1.033 \pm 0.003
166	1.573 \pm 0.011	2.410 \pm 0.005		
194	1.553 \pm 0.008			1.204 \pm 0.020
222		2.583 \pm 0.003		1.337 \pm 0.005
316		2.809 \pm 0.005	1.295 \pm 0.006	1.829 \pm 0.006
413		2.654 \pm 0.004	1.222 \pm 0.005	1.901 \pm 0.009

invertebrates of solid particles with the same C/N ratio as the remaining litter, while on the moder, loss is due to the solution or gaseous evolution of material rich in carbon but poor in nitrogen. A full account of these investigations will be published elsewhere; these results are given here to illustrate the potentialities of the nylon-net technique.

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